Review of "Northern Greenland transect stacked ice cores as a proxy for winter extreme events in Europe", by Gagliardi et al.

This short paper discusses how a Greenland isotopic data can record information on winter blocking events over the North Atlantic region. The paper is based on isotopic data and a long reanalysis, and performs various statistical analyses. The authors propose physical interpretations by determining how water is transported in the atmosphere.

The paper is interesting and fits nicely in the scope of Climate of the Past. I have a few remarks that could be integrated easily.

Major comments

Investigating the relation between this isotopic record and blocking events and the consequences on surface variables is probably innovative. The authors mention very recent references, which is fine, but could also have searched for references at the turn of the 21st century, who looked at relations between the atmospheric circulation and surface variables, e.g. (Meeker et al., 1997). The relationship between atmospheric patterns and surface extremes has been investigated since (Robertson and Ghil, 1999; Yiou et al., 2012; Yiou and Nogaj, 2004), just to cite a few. And the relation between the jet stream and European extremes was recently discussed by (Xu et al., 2024). Therefore, a more thorough bibliographic search would certainly be welcome, to put the results of the paper in a fair perspective.

The adjective "extreme" appears in the title and in several instances of the manuscript. The only extremes that are discussed are the values of the isotopic record, not hydrological or temperature extremes in Europe. The authors essentially discuss "warmer/colder" or "wetter/drier" than normal, which does not correspond to usual definitions of extremes. This should be amended in the manuscript.

The authors quickly deduce from Figure 2 that the relation between the isotopic record and the atmospheric circulation is unequivocal. In order to draw any conclusion between local (European) surface variability and blockings in the past, the authors should also determine the expected value of the isotopic record conditional on the occurrence of blocking (what they compute is Z500 conditional on the value of the isotopic record).

The paper could also have discussed a few key events that occurred since 1600, including volcanic eruptions, solar minima, etc.

Specific comments

l. 70: the description of PRCPTOT is not clear. Cumulated over what time scale?

l. 73: the data description is not very informative. What is the input of the AI reconstruction? What is its added value here?

l. 84: I do not understand what "[…] series assumes high and low values according to certain thresholds." Please rephrase.

l. 86: Why does a +/- 1 sigma threshold meet "both criteria"?

Figure 1 (and text): how is sigma computed? What period? sigma obviously increases with time in Fig. 1c.

Eqs. (1) and (2): I assume that the blocking indices are determined on daily time scales. Most papers (including (Tibaldi and Molteni, 1990)) use a lowercase \phi for latitude.

l. 126: Here, and in many other places, the authors are very qualitative: Figure 2a shows a cyclonic anomaly over the North Atlantic (albeit not as deep as the cyclonic anomaly over Greenland in Fig. 2b). The absence of symmetry in the maps of Fig. 2 is not very surprising. The values of Z500 and wind speed anomalies are symmetric over Greenland, though, which is the first criterion expressed by anomalies of the isotopic record. Since the North Atlantic atmospheric circulation goes eastward, and yields geostrophic features (regardless of the presence of a blocking feature), no real symmetry of the Z500 field east of Greenland should be expected.

l. 170: The association between high pressure patterns with increased frequency of synoptic-scale blocking circulation is demonstrated by (Yiou and Nogaj, 2004).

l. 178—206: the discussion is very qualitative, with many adverbs ("clearly", "remarkably", "notably", etc.) that could be assorted with numbers, to reach objectiveness.

l. 199: verb missing in sentence.

Figures 6 and 7, l. 237: the results that are reported do not say anything about extremes, which are in the tails of the distributions. None of the figures show any change in the tails of distributions. It is already interesting to discuss how the centers of the distributions change.

l. 240: why would it be "logical" to extend this study to other ice cores? Would any change (especially for other Greenland ice cores) be expected? If so, this would rather invalidate the whole approach, wouldn't it? As a perspective, what would seem natural (to me), would be to investigate the how natural forcings can affect features of the atmospheric circulation. This issue is barely discussed in the manuscript, while it is a key aspect of paleoclimate studies.

References

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